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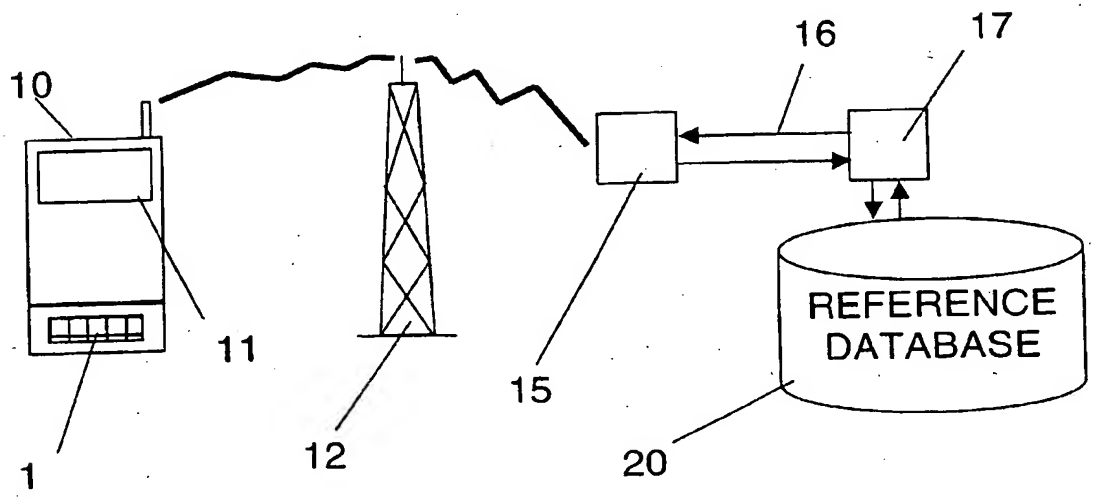
(54) Title: A SENSOR, SYSTEM AND METHOD FOR MONITORING AN ENVIRONMENT AND FOR COMPARING SENSED INFORMATION WITH REFERENCE DATA



(57) Abstract: A sensor and system for monitoring one or more environments and a method and computer software means for carrying out same. A measurement of a parameter in an environment such as a chemical substance is made by a sensor means. A signal containing information from the sensor means is communicated via a telephone and a communication network to a remote reference database for evaluation by comparison. On comparison with information stored remotely the parameter measurement value is identified and quantified. Thus for a chemical substance, the substance is identified and a concentration at the sensor means established. The preferred communication device is a mobile phone and the remote reference database is reached via network such as the Internet.

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A SENSOR, SYSTEM AND METHOD FOR MONITORING AN ENVIRONMENT AND FOR COMPARING SENSED INFORMATION WITH REFERENCE DATA

TECHNICAL AREA

This invention relates to a sensor, system and a method for monitoring an environment and for comparing sensed information with reference data. In particular, but not exclusively, the monitoring allows the detection and possible analysis of one or more, typically undesirable, chemical substances in an environment; the monitoring of process parameters; the monitoring of human and/or animal conditions; the detection of explosive and/or flammable materials; and the monitoring of edible products. The invention also relates to sensing means, a communication device, a reference database and a web site for performing the method.

TECHNICAL BACKGROUND

There are many situations in industry in which it is necessary to detect the presence of a chemical in the surrounding environment. It is for example a common requirement to analyse a fluid such as a gas and determine if a particular chemical substance is present. In some situations it may be required to detect an odour, for example in process control or development of products in the food industry. Another more general requirement in industry is to detect the presence of toxic or environmentally harmful chemical substances such as herbicides, pesticides, halogenated hydrocarbons or even explosives. The monitoring of an industrial environment may also be required, for example, to the presence, absence or build up of, for example, simpler compounds such as Oxygen, O_2, Carbon Monoxide, CO, Carbon Dioxide (CO_2), Ozone (O_3) in manufacturing processes, and the leakage of raw materials,

process fluids or gases, from by-products, intermediate products in factories, warehouse and refineries.

There is also a need in everyday life at home and other non-industrial environments to be able to detect the presence of certain chemical substances. For example there is the need to be able to detect gases emitted by food and food products, to monitor the atmosphere within a building, for example a dwelling, for detecting the presence of chemical substances for example CO, CO2, or environmental hazards such as Radon (Ra). Also persons with particular needs such as allergy and asthma sufferers need to be made aware of the presence of chemical substances in the air inside and outside their homes.

Sensors are available for detecting the presence of chemical substances using many techniques. US-A-5,356,594 describes a portable volatile organic compound monitoring system in which a gas is drawn into an analysis chamber and then ionized. A sensor responsive to ionized gases produces an output signal, which is then matched in the portable system to characteristic data stored in the device. An output is produced indicative of a volatile organic compound (VOC) concentration measured in the vicinity of the device.

Many gas sensors are commercially available that use Metal Oxide Semiconductor (MOS) technology, typically a tin oxide, and metal-oxide-semiconductor-field-effect-transistors (MOSFET).

Another known sensor is described in WO 99/08105 and comprises a plurality of sensor elements arranged in a sensor array and each comprising different combinations of semiconducting, insulating, capacitive and inductive materials. The individual sensor elements of the sensor array react with chemical substances in a gas or liquid sample to produce an electrical signal which may be compared with stored signal samples for detecting and identifying a chemical substance. Differences with respect, for example, to

time in signals between other, typically nearby, sensor elements may be used to determine concentration of a detected substance. The sensor array output signal may be matched to data stored in a part of the electronic circuit associated with the sensor array circuits. This type of technology is sometimes called an electronic nose as it is often compared to mechanisms present in a nose or other olfactory organ.

As well as chemical substances such as organic or inorganic compounds, such sensors may also be used to detect substances that indicate a health problem or other physiological condition of a person. For example an abstract for DE-A-29902593 discloses a semiconductor based gas analysis apparatus, which can be used to detect ammonia in a breath sample for diagnosing an infection with helicobacter pylori. The signal pattern is compared with an ammonia pattern in the database to diagnose any infection with helicobacter pylori. Likewise, if hydrogen is detected in a breath sample the signal pattern is compared with a stored known pattern for hydrogen in the database so facilitating a diagnosis of an intolerance to lactose.

An article "A New Pollen Detection Method base on an Electronic Nose", E-L Kalman et al, Atmospheric Environment Vol 31, No. 11, pp 1715-1719, 1997 describes a method in which a gas sensor is used to sense samples of pollen. In this description the pollen samples were pyrolised. The sensing measurements were compared using commercially available artificial neural network software and Principal Component Analysis (PCA) software.

US-A-5,496,700 discloses an optical sensor in which optical waveguides, typically based on optical fibres, capture a light signal emitted from microbial substances stained with non-specific dyes. The light signal is primarily assessed dependent on fluorescent light in the signal. Rapid sample analysis times are described.

US-A-5,809,185 describes a method of detecting microorganisms in which a waveguide coated with a fluorescent coating contacts a microbial sample. A shift in a light signal transmitted through the waveguide depending on fluorescence due to microbial presence is measured.

It is also known to use an array of optical fibres with slightly dissimilar optical properties to capture light transmitted through a biological material sample and to derive from the characteristics of the transmitted light complex information such as the identity of a pathogen or virus.

An article entitled "Portable electronic nose system with gas sensor array and artificial neural network", published in Sensors and Actuators B 66 (2000) 49-52, describes a portable sensing system based using an oxide semiconductor gas sensor array arranged together with use of back-propagation artificial neural networks.

The system is shown in Figure 1 and comprises the gas sensor array P2 arranged with an Analogue/Digital (A/D) converter P3, an Intel (Trade mark) 80c196k microprocessor P5, further arranged with an EE Programmable Read Only Memory (EEPROM) chip containing neural network system weights and an Liquid Crystal Diode (LCD) Display to show a resultant concentration of a detected gas. There is also described a method of using a Principal Component Analysis (PCA) to project data from several sensors to a two dimensional plane. A neural network using a three-layer system of 6 inputs, a fifteen unit hidden layer, and a 26 unit output layer was used to identify different gases. The portable nose system arrangement is connected by a cable P8 using an RS232 serial communication input to a notebook computer P9. The notebook computer is used to read out the sensor outputs from the sensor array P2 and train the optimum connection weights among three layers of the artificial neural network. The artificial neural network can be implemented as a computer program on the notebook computer as a computer program.

The optimised connection weights for the neural network are then sent for storage in the EEPROM chip via the RS232 cable P8. Once the optimised weights are stored in the EEPROM, that system can identify up to 26 gases gas species and concentrations, for example from car exhaust gases, without being connected to the computer notebook P9.

However the portable nose arrangement shown in Figure 1 has a limited capacity for the number and scale of patterns for matching that may be stored and or processed in order to match a chemical substance. Moreover, the arrangement only describes how to analyse a small set of chemical substances.

An application WO 0052444 entitled "Apparatus, systems and methods for detecting and transmitting sensory data over a computer network" discloses a portable gas sensor arranged with an analog-to-digital converter and describes certain means to transmit a digital signal over a computer network, including networks such as the Internet, for analysis at a remote location. A handheld apparatus is described that includes a housing, a sensor means, a processing device configured to identify or quantify analytes within a test sample based on a particular response, and a communication interface coupled to the processing device and configured to communicate with a computer network.

SUMMARY OF THE INVENTION

The aim of the present invention is to solve one or more of the above problems. It is also an aim of the invention to enable sensed information of a monitored environment to be compared or matched with reference information at a remote location.

It is another aim of the invention to make use of telephonic communications for enabling sensed information to be compared or matched with reference information at a remote location.

According to different aspects of the invention there is provided a sensor means as claimed in the ensuing claim 1, a system according to the ensuing claim 44, a method according to the ensuing claim 59, a computer data signal according to the ensuing claim 92, and a computer program product according to the ensuing claim 94.

The invention enables sensed information about a monitored environment to be compared with reference data at a remote location, for example, a database. The communication means, such as a mobile telephone, is able to transmit the sensed information to the remote location for analysis with the reference data.

A particular advantage provided by the invention is that it provides an easily available and economic system for extensive and sophisticated identification and quantification of aspects of an environment. The system provides for processing and matching of signals dependent on locally sensed information with reference information stored at a remote location. The reference information may be stored in a database containing a virtually unlimited number of signal patterns and other signal information data. By using a sensor unit locally and communicating a measurement signal to the remote reference database the sensor unit may be arranged as a small, simple, lightweight and inexpensive device that may be used in a immense variety of contexts to obtain sophisticated and important results or information.

The invention may be applied to monitor many different environments. For instance, the invention may be used to identify chemical substances and to measure the amount of such identified chemical substances present in a particular environment; to identify an occurrence and characteristics of an optical signal; to detect odours in process control or the production, processing or development of products such as foods and cosmetics; to monitor environments hostile to humans and/or animals, for example dogs; and to monitor economically and automatically known or predictable

substances in factories, manufacturing process, oil refineries, oil and gas pipelines, and so on.

The invention can be used, for example, by process technicians, security personnel, firemen or police patrolling or visiting a site, plant, complex or building. Equally the invention enables a member of the public to measure an environmental parameter in a home, in a public place and so on.

The invention also has medical applications as it may be used to monitor and detect in the atmosphere chemicals such as pollutants, and substances causing sickness or injury. Additionally the human body may be monitored by means for example of breath or other samples, to detect ingestion of harmful substances, drugs and the like.

Another advantage in use is that use of one or more remote reference databases permits a signal, which may potentially be sent from or come from anywhere in the world, including the atmosphere or in space, to be matched with an almost limitless and expandable "library" of reference information. Such a reference "library" may also be updated over time following development of newer sensor technologies, new substances or sensor measurements of interest and new methods of forming or generating patterns and matching or identifying those patterns, newer programming algorithms, newer computer technologies. It will be appreciated that a plurality of differently located sensor units may use a common database, and that a plurality of sensor units owned and operated by different owners or operators may also use a common database.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with particular reference to the accompanying drawings in which:

FIGURE 1 (Prior Art) is a schematic diagram of a portable electronic nose system according to the Prior Art;

FIGURE 2 is a schematic diagram showing schematically one embodiment of a system according to the invention for monitoring an environment;

FIGURE 3 is a block diagram showing schematically a sensor unit of the system shown in FIGURE 2;

FIGURE 4 is a block diagram of a reference database for use the system shown in FIGURE 2;

FIGURE 5 is a flowchart illustrating a method of detecting and identifying a chemical substance using the system of FIGURE 2;

FIGURE 6 is a schematic diagram of another embodiment of a system according to the invention based on the use of a network or intranet for detecting chemical substances;

FIGURE 7 is a schematic diagram of a further embodiment of a system according to the invention for detection of chemical substances using a short range wireless communication technique;

FIGURE 8 is a schematic diagram of a reference database according to another embodiment of the invention; and

FIGURE 9 is a schematic block diagram of a sensor unit according to a further embodiment of the invention.

FIGURE 10 is a schematic block diagram of a data structure of a data signal or data file communicated in and/or by a system according to the invention.

FIGURE 11 is a schematic diagram of a sensor unit connected to a communication device according to an embodiment of the invention.

FIGURE 12 is a schematic diagram of a sensor unit connected to a communication device according to another embodiment of the invention.

FIGURE 13 is a schematic diagram of a sensor unit connected wirelessly to a communication device according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The invention will initially be described in respect of a sensor arranged with a telephone or mobile telephone for communication with a monitoring system for detecting the occurrence and concentration of a chemical substance in an environment.

A first embodiment of the present invention is shown in Figure 2. The system comprises a sensor unit 1 incorporated in a portable device such as a telephone (hereinafter referred to as a "mobile phone") 10. The mobile phone is configured for access to a telephone network via a base station 12 and is connectable to a network 15, such as the Internet. A data connection means 16 also connects the Internet 15 to a computer 17 which is able to access a reference database 20.

In a preferred mode of operation of the present invention a sensor means in the sensor unit 1 generates an electrical sensed signal. The sensor unit 1 sends the sensed signal to a suitable data input feature of the mobile telephone 10. The signal received at the mobile phone may be further processed to associate additional identity information, optionally comprising one or more of

-the sensor type,
-an Electronic Serial Number (ESN) number and or
-Mobile Identity Number (MIN) number of the mobile phone.

Figure 3 shows the sensor unit 1 in more detail. The sensor unit 1 includes sensor means such as a sensor array 2 which is connected so as to supply sensed signals to an amplifier and signal processor 3. The sensor array 2 has an identifying data, such as a number, character string or combination thereof, which identifies the sensor array. This identity data is stored in a memory means, for example a permanent memory means, such as a ROM chip 4. The signal processor 3 is connected to a computer or microprocessor 5 having an interface means such as an Input/Output (I/O) unit 6.

Figure 4 illustrates in more detail the remotely located part of the monitoring system shown in Figure 2 which incorporates the reference database 20. A signal transmitted from the mobile phone 10 is received at the previously described computer 17. This received signal contains information representative of the environment being monitored together with, for example, information identifying the sensor unit (which may be one of many different sensor units associated with the system). The computer 17 interfaces with an interface 18 for the reference database. A user is identified by matching at least one of the sensor identifiers, identifiers such: as communication unit identity; incoming phone number; incoming address; incoming Internet Protocol (IP) address; with data stored in a database 26 containing user contract details and configured for access by the interface 18. The incoming transmission of signal information from the sensor unit may optionally be further processed if necessary, in a signal processing stage 24, to convert the signal to one containing a pattern for recognition.

For example, the signal may be treated in a process according to a Principal Component Analysis or other statistical technique to form patterns representing characteristics of different constituents, concentrations or both, of one or more chemical substances occurring. If the signal does not require such processing it is sent directly to a matching device 19. The matching process is performed by comparing the pattern of

information in the incoming electrical signal with patterns stored in the reference database 20. The result of the comparison, whether resulting in a positive or negative identification, is sent by device 22 to a pre-determined destination in a predetermined format. The pre-determined details are retrieved, for example, from the user contract details in database 26. Formats such as such as WAP, SMS, fax, voice call, pager or beeper display or signal, e-mail etc may be so pre-determined.

The data transmission function of computer 17 to transmit an incoming communication to and from the remote reference database may alternatively be carried out by another hardware means such as a network node, a hub, router, network card or the like. This alternative arrangement is available in particular when the reference database is arranged with computer means and server means that may carry out the interface, processing, matching etc. functions described.

Referring again to Figure 2, the sensor signal processed and associated with sensor identity means is sent via a mobile telephone network to a computer 17 or equivalent network node. The computer may be reached via a closed local network such as a Local Area network (LAN), a closed global network or intranet, or via an open global network such as the Internet 15. The signal is received by the computer 17 and processed by a computer program means to express the information contained as a data pattern of one sort or another, further described below, which data pattern is compared to stored samples of data patterns from signals representing chemical substances which are arranged for that purpose in the remote reference database 20. The result of the comparison is returned to the computer 17, and the computer then sends the result to a pre-determined destination for reporting. In this way the chemical substance and concentration is identified and reported.

In the preferred mode of the first embodiment the result is returned to the originating mobile phone 10 where the result may, for example, be displayed on a graphic display 11 of the phone. The result may be returned during the duration of a single telephone call or, as a measurement that is taken and reported in real time if not simultaneously. Alternatively the result may be delivered by sending a message to the originating mobile telephone at a subsequent time.

The identity of the sensor unit 1 and communications means or mobile phone 10 that has contacted the reference database 20 is recorded in a storage unit, such as the user contract details database 26 shown in Figures 4, 8, associated with the reference database. In this way information is available for billing the owner of the communication means or phone that has accessed the database. The billing information may be very detailed because the incoming signal is accompanied by data identifying the sensor unit.

In addition, other data related to the incoming communication is normally available from an ordinary Public Switched Telephone Network (PSTN) telephone company, a long distance carrier or cellular telephone company from standard billing practices that record telephone numbers and call duration or times. Typically a public land mobile network (PLMN) comprises a cellular telecommunication system that is based on cells or similar radio coverage areas. Examples of cellular radio telecommunications systems, without limitation to these, includes standards such as Global System for Mobile communications (GSM), or various GSM based systems such as General Packet Radio Service (GPRS), American Mobile Phone System (AMPS), Digital AMPS (DAMPS), Wideband Code Division Mutliple Access (CDMA) in Univeral Mobile Telecommunications System (UMTS), IMT 2000 and so on. Other systems suitable for use with the invention include satellite phones, such as those used with services provided such as Iridium LLC (Trade Mark), Inmarsat (Trade Mark), Inmarsat I-4, ICO

Teledesic and ICO Global Communications, and Loral Space & Communication's system Globalstar (Trade Mark). Other systems that may be used with the invention are phones equipped with a Bluetooth or similar short range radio link, and cordless phones, such as those commonly used within a particular building, factory, complex etc., often in conjunction with a Private Telephone Exchange (PABX) system or else a telephone in a home or otherwise delimited area.

Dependent on the particular application that a system according to the preferred mode of the first embodiment is used for, the details used for billing purposes by the monitoring system according to the invention may include any of:

-calling phone number and area code
-time of access,
-duration of time to make a comparison,
-MIN and or ESN number,
-sensor type,
-sensor array type,
-sensor identity,
-type of signal processing to form a pattern for matching,
-identity or type of database accessed,
-type of search or matching process,
-instructions for reporting result
-result reported,
-time of reporting result.

A method of monitoring according to the invention is illustrated as a flow chart in Figure 5. To facilitate description the steps 400 to 411 will be described in order.

At step 400 an environment is sensed and a decision is made at 401 as to whether the sensed signal has sensed a particular substance. This may be a non-automatic, human decision, a semi-automatic decision involving an operator confirmation or similar, or an automatic decision dependent on time, temperature or similar, or a

measurement value. A sent signal is associated with the identity of the sensor in step 403 by retrieving the sensor unit identity from a memory means such as item 4, shown in Figure 3. The associated signal and identity means is sent at step 404 by an interface means to the remote reference database. It is sent via a communication means such as the mobile phone 10, over network means such as Internet 15; Figure 2, to the reference database.

At step 405 an interface, identified by reference numeral 18 in other figures, receives the incoming signal and directs it further. At step 406 the identity means in the incoming signal is compared to user contract details in a user contract details database 26 (see Figures 4 and 8). The incoming transmission of signal information from the sensor unit may optionally be further processed in signal processing step 407 to convert it to a signal containing a pattern of information for recognition. If the signal does not require such processing it is sent directly to a comparison process in step 408.

The signal comparison process is then carried out in step 408, comparing the information contained in the incoming signal with data patterns or algorithms stored in reference database 20. A positive comparison result is prepared in step 409, and, if so required according to user contract details, a comparison resulting in a negative match result, such as "Radon tested for and not found" may also be prepared for sending. At step 410 information is also be passed to a billing system for recording transactions and generating invoices for those contracts that are billed dependent on each access for a match. At step 411 the match result is sent. Optionally a confirmation of receipt may be recorded at 411.

Additionally in a development of the first embodiment the information available for billing purposes is also made available for at least two other functions.

Referring to Figure 8. A User History database 25 is additionally arranged configured with the remote reference database. First, a calling and user history is maintained for those environment monitoring systems registered with the database in question that require that information to be stored. This user history enables subsequent calls to be processed optimally, as the computer programs, computer program products and software in an interface 18 to the reference database routing the signal and setting up the comparison process can optimise a comparison process. This is achieved by, for example, selecting from among positive results found from the calling environment monitoring system's history the same types of pattern and trying those first in a series of comparisons. An artificial neural network learning may be typically applied to recognising and matching patterns derived from chemical substances. More successful comparison processes for sensor signals in general and also for signals concerning particular substances in particular may be identified by this method to improve speed of response and accuracy.

Secondly the data is made available for statistical analysis and/or data mining by the reference database owner or operator in order to, for example, provide statistics and trends, improve effectiveness or provide value-added services.

Many types of filtration schemes and matching schemes are available for use in a remote reference database of the system according to the invention. For example, a software application based on neural network mechanisms and logic may be used to classify signals representing different substances. An example of a method for analysis and neural network training is described in an article "Electronic Noses and their Applications in Environmental Monitoring", S. Hashem, P.E. Keller, L.J. Kangas, pp 74-81 Proceedings of the 1995 Workshop on Environmental and Energy Applications of Neural Networks. The article describes the use of artificial neural networks to analyse real-time data from a sensor array based on commercially available Taguchi-type gas sensors.

Another suitable pattern recognition scheme is described in and article entitled "Picture the Smell", I. Lundström, NATURE, Vol 406, 17 August 2000. The author discusses recognition schemes including a polar diagram for sensors of the electronic nose type. A different type of sensor is also described in which a plurality of adjacent sensor elements in a gas sensor array displays a different colour change according to different substances and different concentrations of those substance instead of sending out certain electrical signals.

Another description of pattern recognition schemes may be found in "Gas sensors for automobile interiors", Eva-Lotta Kalman, Dissertation No. 655, Linköping University, Sweden. Pages 21-27 discuss statistical analytical techniques including PCA, PLS and Multiple Linear Regression (MLS).

The reference database 20 is accessible over the Internet 15 or over a network such as a LAN or an intranet. A dedicated web site for one or more reference databases may be established according to the known art of providing web sites. In most cases the web site will include access and log-in processes suited to different types of users and to users carrying out different tasks. Log-in procedures and means to provide them are well known to those skilled in the art of providing web sites. When an environment monitoring system is established, for example, a first type of log-in is provided so that the system owner or operator can select and specify technical requirements, matching schemes, reporting destinations and requirements, reporting format, reporting media, normal and exception reporting measures, contract type and billing details. Subsequent log-ins by the owner or operator may be processed to give access to environment monitoring system access history or summarised or in some other way value-added reports provided by the reference database owner or operator. Additionally subsequent log-ins may also be used by an operator or owner of an environment monitoring system to update or alter configuration aspects such as reporting requirements, dial-up phone number etc..

A second type of log-in is provided for access by an environment monitoring system to the reference database for submitting a signal from a sensor and starting the process to compare information from the sensed signal and identify a chemical substance or other parameter measured from the environment. There may be more than one type of log-in process for the second type of log-in according to a predetermined access mode and, for example, degree of security and or validation required by the owner or operator of the accessing monitoring system.

In a preferred embodiment the signal information generated by the sensor and the sensor identifying information are sent via a communication means such as a mobile phone in any of a plurality of different formats. A Short Message Service (SMS) phone call is one such preferred format for a signal for which a report is not needed in real time and typically has a lesser data content. Other services are available using for example Wireless Application Protocol (WAP) or WAP 2.0 adapted phones, I-Mode system phones, satellite phones, any of which may equally be used to communicate the sensor signal and monitoring system identifiers in a short message or as a digital file to a remote reference database.

I-Mode service, which originated in Japan, is designed for access by a wireless packet network, a packet switched network, and as such may be more "Internet friendly" than WAP and may be more suited to the coming generation, "third" generation or 3G mobile phones and associated services. WAP, which is becoming widely available in North America and Europe works over circuit- and packet-switched networks – including GSM, code- or time-division multiple access. WAP relies not on Transmission Control Protocol/Internet Protocol (TCP/IP) but on datagram protocols which may be said to be a "lowest common denominator" that works across differing network infrastructures. Because current WAP service is based on circuit-switched data, this generally requires a longer connection time and time-based charging, making the service potentially somewhat more expensive.

Thus information including sensor signal from a sensor system may be communicated as a digital file containing at least

-the sensor signal output,

-and optionally sensor identity data,

arranged in a format or written to a file that suits a particular communication means.

For example, when a data network such as an intranet is used, a file format derived from any of the protocols evolved from Standard Generalised Markup Language (SGML) meta-language such as Hyper Text Markup Language (HTML), eXtended Markup Language (XML) and derivatives such as XHTML 1.0, Extended Stylesheet Language (XSL) and the Document Object Model (DOM) that may additionally provide access to data in another digital file from within the digital file sent by means of embedded XML links, tags or pointers or similar. For example Wireless Markup Language (WML), which may be used with a WAP telephone is a derivative of XML.

As described previously, the reference database is conveniently accessed over the Internet via a web site provided for that purpose. An accessing environment monitoring system may be logged-in in a number of alternative ways as described above. The web site computer software which comprises a form of interface to the reference database and matching process is implementable at least in part by means of Hypertext MarkUp Language (HTML) code, Java (Trade Mark) type programming or scripting, using XML enabled pages and the like with open standard web browser and TCP/IP techniques.

The contents and reporting routines for an attempt to compare and or match a signal information from an environment monitoring system are either included in instructions accompanying the incoming signal or predetermined by a contract between the owner or operator of the parameter measurement system and the owner or operator of the reference database being accessed. Such contract details are conveniently stored in the database 26 (see Figure 4),

configured for retrieval of individual environment monitoring system contract details such as matching schemes, reporting requirements when a sensor signal is first received at the reference database 20 or interface 18 to the reference database. If no contract has been established then an accessing user may use software means in the web site to register via the web site and to begin a contractual relationship.

The report for a match result for a chemical substance is sent to the predetermined destination where it may be

-displayed on the originating phone display,
-sent as an SMS message to the originating phone,
-sent as a voice message to the originating phone,
-sent to a beeper or pager number,
-displayed on a predetermined computer system,
sent to a computer or an apparatus in, or in control of, or in a control system of an industrial process,
-sent to a predetermined e-mail address,
-sent as a fax to a predetermined number,
-sent for data logging to an electronic address or file,
-sent to a centre for reporting emergency situations.

A combination of one or more of the above reporting destinations may be also be carried out. The format for display of the matching result report may be selected to suit the application and industry etc of use. Typically this is in a form such as:

-an SMS message,
-a character display,
-a graphic display using vector-based graphics,
-a graphic display using bit-mapped graphics,
-HTML display means on a screen of a computer or hand held device,
-graphic information
-an electronic document such as according to a standard for EDI.
-a distinctive sound, musical signal or voice message.

The result may also optionally be displayed together with, or with links to, pre-selected information or instructions such as Material Safety Data Sheets (MSDS) retrieved from a designated database of technical information, industry specific for example, relevant to handling specific chemical substances or a register of poisons. Optionally a list or register of suitable contractors and or companies that provide a suitable service or carry out subsequent analysis may be provided.

Alternatively the environment monitoring comparison report may also conform to one or more current standards for electronic documents used for Electronic Data Interchange such as EDIFACT or ASC X12; and/or to similar standards issued by other recognized bodies including commercial or financial organizations such as the Society for Worldwide Interbank Financial Telecommunication (SWIFT). Other current standards capable of use for electronic data interchange include XML and other modern protocols Microsoft's (Trade Mark) MSXML or a standard called XHTML 1.0 provided by World Wide Web Committee (W3C).

Thus the environment monitoring result report may be in the form of an electronic document that otherwise corresponds to a traditional EDI electronic document. As such, the file transmitted containing the substance matching report comprises necessary details such as any of:

- -identification of document type,
- -authorization details,
- -security details,
- -contact details,
- -acknowledgement request details,
- -contract references for database owner, environment monitoring system owner

as well as previously described information for a report, especially

- -sensor type,
- -sensor unit identity,

-signal processing requirements,
-matching scheme,
-special requirements
-reporting requirements
-exception or emergency requirements.

In the case that communication service reporting the result is temporarily not available, such as when a mobile phone specified as report destination is switched off or out of reach of telephone service, alternative reporting measures must be taken. For example the result may be stored at the remote reference database or extension thereof. The result is then either signaled to the phone, eg as an SMS message to ring and collect, or queued for subsequent repeated attempts to retransmit, or sent to alternative destinations as recorded in the pre-determined reporting requirements. In a further embodiment, the report may be combined with a report from a telephone company indicating the location of the originating telephone or GSM phone at the time of sending the sensor signal.

Figure 6 shows a network or intranet based environment monitoring system according to the first embodiment of the invention. The system comprises a communication means such as a cordless or mobile phone 10, equipped with a sensor unit 1, and a network, LAN or intranet 30. Intranet 30 is equipped with a wireless receiver node 31. Intranet 30 also has a node 32 to which a computer 17 is connected via any of the known protocols for a network or intranet. The computer is connected in turn via an interface 18 to the reference database 20. In the intranet embodiment of the present invention a signal from a sensor of an environment monitoring system may be connected to the remote reference database by means of an intranet or LAN network or similar.

In practice this means that a process technician, security guard, watchman, fireman or another person can walk around a building or drive around a complex with a portable device as described and

take a measurement and send a resulting signal with information for analysis via a local network serving the plant or complex etc.. The remote reference database may be an in-house database connected directly to that network. Such an arrangement for an airport, an industrial plant, an oil refinery, a factory or a commercial building or a complex easily enables a portable device such as a hand held computer, PDA or mobile phone to communicate with a remote reference database from anywhere in the plant or complex using an existing intranet or network equipped with a suitable node for connection to the portable device. It is also possible to use the first embodiment with the Internet aspects, perhaps simultaneously, with the herein described network embodiment and so communicate via a communication device and the Internet to the intranet or LAN.

When so desired, a mobile device such as a phone is optionally configured to send a phone call direct to an interface of the reference database without using a network link. In this way, the communication device may access the reference database by means of making a telephone call directly to it.

In the case of a negative match, a delay, or a need for a second or further confirmation the signal may optionally be directed further to an external reference database via the Internet etc as previously described.

In addition to the above commercial and industrial examples a form of local network is increasingly used by persons in homes and residential buildings. Instead of a LAN, a person in a residence may have access to the Internet not only via modems used with telephone lines or ISDN telephone lines to dial up an Internet Service Provider, (ISP) and access the Internet. Internet access is also carried out via other means such as a cable tv service and via, for example, a cable modem. This service is increasingly available in, for example, North America. In other countries other means such as specially installed fibre-optic cable links,

sometimes referred to as broadband networks, are available. This means that a person in a residence may use a broadband connection and network to send a sensed signal from a sensor, via the Internet, to the remote database.

Common variations of networks available in residential homes and buildings that may be used in an aspect of the invention include: set-top boxes to send an interactive signal via a tv service provider; internal networks based on data communication superimposed on the household domestic mains AC power supply; and networks internal to a building or complex typically, but not exclusively, wire based networks such as existing systems including functions such as paging, alarms and door entry signals.

The identity of the sensor unit that has originated a sensor signal is identified according to the invention in one of at least three ways. Firstly, the sensor unit itself optionally combines at least the sensor type, and preferably a sensor identity number, with a sensor signal before transmitting it to a communication device. In this way it is known which of potentially thousands of sensors in an industrial plant has sent the received signal.

Secondly the sensor type and or a sensor identity number is optionally added in the communication device. Within a circuit of a mobile telephone or add-on memory card etc, the sensor identity is retrieved and sent with the signal in the same transmission to a remote database 20. Thus the identity of a limited number of sensors each using the same communication device such as a mobile phone 10 is known or can be found.

Thirdly the sensor type and preferably sensor unit identity is stored in the remote database and retrieved to match a transmission from a known incoming phone number or IP address, URL etc.. Thus the sensor identity may also be "added" to the signal by the remote database when the sensor signal reaches the remote database. The preferred method of identifying the sensor and the

sensor unit is established in the basic contract between the owner or operator of the sensor unit and the owner or operator of the database. A copy of the selected method for recognising and or assigning identity information to incoming transmissions is included with the predetermined reporting requirements for each user contract.

Second embodiment

In the first embodiments of the invention a sensor of some type is built in to a communication device such as a mobile phone. According to a second embodiment of the invention herein described the sensor is not physically attached to the communication device but is connected either by an electrical connection or by a wireless means.

A sensor is optionally connected by means of an electrical wire or cable suitable for transmission of a measurement signal. The connection may take the form of a plug-in unit, which using a plug-and-socket arrangement allows a sensor unit to be plugged into a phone using a RS 232 type data connection, a Universal Serial Bus (USB) connection or a form of Plug and Play (Trade Mark) protocol. In Figure 11 an expanded view is shown of a schematic plug-in sensor 1'' for attachment to a phone or mobile phone 10 as shown in Figures 2, 6. Sensor 1'' is shown arranged with a plug means 112 to be plugged in to a socket means 113 of a phone 10. Even simpler, a wire or cable from a suitable sensor or sensor unit may be plugged into a suitable input, a serial port such as an RS232, or other similar input feature of a mobile phone or other communication device. In Figure 12 an expanded view is shown of a plug-in sensor 1''' attached by a wire or cable 122 to a phone 10 or mobile phone as shown in Figures 2, 6.

Thus connected, the cordless or mobile phone is arranged to receive a signal from a sensor, of which sensor or sensor unit the sensor probe is placed in contact with a gas, liquid or other material for test. By this means any of:

water;
raw materials, process fluids, product fluids;
oil and petroleum samples;
drug samples, as well as;
biological samples from soil, plants or animals, including a breath test,

may be checked for the presence and concentration of a chemical substance by an environment monitoring system according to the invention.

It must also be described that the invention may be carried out by connecting a sensor means to any electronic device that is equipped or equippable as a communication means. For example many of the electronic devices for playing computer games, consoles, or stations are manufactured by companies such as Sega, Nintendo, Sony and others are connectable to a network such as the Internet to download software or to play games interactively. Thus connecting a sensor means via plug and socket, RS 232 cable or other connection means to, for example,

-a Sony PlayStation (Trade Mark)or Play Station 2 (Trade Mark) or Gscube (Trade Mark);
-a Sega Dreamcast (Trade Mark) console with a built in 56kps modem; or at some point in the near future to:
-a Microsoft Xbox (Trade Mark), or
-a Nintendos Gamecube (Trade Mark) optionally connectable with accessories to an Ethernet connection,

means that via that electronic device a connection can be made to the Internet that enables a person in a household to detect, for example, a chemical substance and match it in a remote reference database according to the invention. A set-top box, that is an electronic device for use in conjunction with a television receiver (tv), commonly embodied as a cable tv signal or satellite broadcast transmission signal decoder, may also be adapted for data communication. One such product is called Media Terminal (Trade Mark) made by Nokia which enables a user to surf the Internet and watch tv at the same time. Other examples of

available communication devices are portable computing devices such as hand held or "palm"-sized computers sometimes called a Personal Digital Assistant (PDA) or Personal Digital Organiser (PDO) of the type manufactured by Palm (Trade Mark), Psion (Trade Mark) and other manufacturers of small electronic devices such as Sharp and Casio. Certain models of Palm Pilot (Trade Mark) PDAs are available equipped with both a RS232 cable input and a connection for a modem, and may thus be used in a system according to the present invention virtually out of the box. Hand held electronic devices used for accessing the Internet in order to use e-mail facilities or even surf the Internet, such as a Sony Airboard (Trade Mark), likewise may be used to send a sensor signal to the remote database 20.

The sensor unit may also advantageously be connected to a communication device or a network by a cordless means. One such means is two-way communication via Infra Red (IR) transmission preferably according to a recognised standard such as that described by the Infrared Data Association (IrDA), including the IrCOMM protocol, any of the IEEE 802.11 standards published by the Institute of Electrical and Electronics Engineers, Inc., or even proprietary standards such as Sony (Trade Mark) SIRCS or Denon (Trade Mark) format. There are standards and formats facilitating access to via protocols including Ethernet, Token Ring, Apple talk etc. to Wide Area Networks (WAN), Local Area Networks (LAN) etc.. Certain models of mobile telephone, such as an Ericsson R380s model GSM phone, and of PDAs such as Palm Pilot Palm IIIx (trade mark) and Palm V (Trade Mark) or Palm m100 (Trade Mark) are typically available equipped with an IR port for data transmission with another device.

Communication using sound or ultrasound between a sensor and a communication device is possible. For example in a petroleum industry application at an underwater site a sound or an ultrasound transmission may be used to transfer measurement signals between a sensor and a communication device. Measurements

such as pressure, salinity and presence of substances in water or oil, such as certain hydrocarbons or oil/water/sand mixtures, are examples of measurements that may be taken for assessment in this way.

Figure 7 shows a system for detection of a chemical substance in which a wireless link is used to transmit a sensor signal to a communication device. A preferred wireless standard such as the Bluetooth (Trade Mark) standard offer a well developed series of methods and means for wireless transmission of data. The Bluetooth Special Interest Group (SIG) has developed a series of standards for short range radio links between mobile stations, mobile personal computers and other portable devices, such as hand held Personal Data Assistants (PDA) and mobile telephones. Full details and technical details may be found in information published by the Bluetooth SIG including at their web site etc, however a summary description is included here to facilitate understanding of an embodiment of the invention. The Bluetooth protocol defines a universal unlicensed Industrial-Scientific-Medical (ISM) band at 2.4 GHz. The 2.4 GHz band is globally available and thus a Bluetooth wireless link is believed to be compatible world-wide for local wireless communication. The range of each radio service area can be, for example, about 10 metres, and the range is optionally extendable to around 100 metres, for example, by use of an appropriate amplifier. The network topology of a Bluetooth system may support both point-to-point and point-to-multipoint connections, thereby enabling communication between several devices at the same time.

Figure 7 shows a schematic representation of a portable or mobile phone 10' equipped with a radio transmitter/receiver unit 35 according to the Bluetooth standard. A number of sensors 101, 102, 103 etc. located in different positions around an area for monitoring such as an airport, a factory, hospital, oil refinery etc. are each equipped with a Bluetooth unit similar to unit 35. Bluetooth units within range of each other may automatically set

up a radio network called a piconet. In Figure 7, the dashed arrows 36 between some of the sensor units arranged with Bluetooth sensors are intended to indicate that those units communicate with each other, and are able to pass data to each other when required. Thus the transmission from sensor 102 may be a signal measured by 102, or may alternatively be a signal from another, nearby sensor that has forwarded a data signal that should be transmitted for assessment.

A Bluetooth wireless unit 35 may be constructed as a single "chip" with very low power consumption connected into any type of measuring instrument or sensor. A Bluetooth chip may generate a standardised WAP packet for sending, in the example shown in Figure 7, via a base station 12 of a cellular telephone network, for communication via a suitable gateway, typically a telephone network-to-Internet interface in the line of communication to the reference database, at which gateway the WAP message may optionally be converted into TCP/IP packets for sending on via a network, such as the Internet.

The Bluetooth chip may alternatively provide suitable protocol or information to forward data as an SMS message. The point being that sensors equipped with a Bluetooth wireless chip may communicate and exchange data with other Bluetooth enabled devices. By this means one or more Bluetooth enabled sensors may send data, by a short range Bluetooth radio link to another Bluetooth enabled device such as a mobile phone 10', which sends the sensor signal with its sensor identity to a remote reference database for comparison with stored sensor patterns. The comparison process result is then sent to a predetermined destination such as a portable mobile device which may be the originating phone, or may be any other device including a desktop computer, notebook computer or portable computer, for display.

Figure 13 shows diagrammatically a sensor unit 1 and a communication device such as a phone 10 equipped with wireless

communication means to illustrate embodiments described above. Figure 13 shows a phone 10 equipped with a wireless receiver/transmitter 133 and a sensor unit 1'''' equipped with a wireless receiver/transmitter 132. Wireless communications 135 are shown between the phone 10 and the sensor unit 1''''. As described above the wireless communication means may be any RF means such as to Bluetooth standard, IEEE-802.11 or equivalent. Wireless communication 135 may also be carried out Infra Red (IR) means such as IrDA, IrCOMM or equivalent. Wireless communication 135 may also be carried out using sound or ultrasound transducers.

Third embodiment

In a third embodiment the sensor means in sensor unit 1 may comprise a sensor array 2 or a gas sensor array as the sensor means. However the present invention is not limited to sensor arrays but may comprise other types of sensor for measurement during monitoring of an environment, such as a sensor arranged to respond to:

-ionizing radiation, such as a geiger-type sensor,
-a graphic pattern, such as a scan of a finger print, a hand print, a skin pattern, a retina scan, or other biometric sensor application,
-a pH level,
-a light signal including a fluorescent component or wavelength indicative of substances of bacterial or other microorganism origin,
-UV light,
-IR light or radiation as a measure of temperature or fire etc, IR light transmissions such as for monitoring, surveillance at night,
-a sound - such as a gunshot, breaking glass, a voice, ringing telephone, an alarm bell, buzzer, or siren,
-an ultrasound transmission,
-a pressure pulse in a solid, including of seismic origin, and in a fluid,

-smoke and soot or other products from a heating, pyrolysis or combustion process,
-a tissue sample for analysis.

A signal from a sensor means such as those listed above may be processed to extract information, associated with an identifying data means, communicated to a remote database and compared to stored patterns of information or information data according to the third embodiment of the invention.

The signal from the sensor means is preferably arranged as a computer data signal. US 5,850,449 describes a secure network protocol system and method. In the description a packet of data is described embodied in a data signal. It is shown that data means may be included in each data packet to identify a given data protocol in addition to a so-called data payload (ie the message) and a packet header and a packet "trailer" or footer.

See Figure 10. The information from the sensor means embodied as a data signal for communication in a computerised system is dependent on a measured value of a monitored environment, for example an environmental parameter or chemical substance such as previously described. The data signal shown schematically as 501 ordinarily comprises identifying data means 502 to identify at least the originating sensor type and optionally the unique sensor means in one first data part of the signal 502. The sensed measured value 505 from the sensor means is stored in one second part 504 of the data signal 501. Preferably identifying means 503 comprised in the signal 501 begins with a marker in the first character blocks to the left of 503 in the diagram. Similarly it is preferable that the measured value 505 comprised in the second part 504 of the data signal 501 also begins with a marker in the first character blocks to the left to declare that the measured value begins there. The data signal is transmitted further to the communication means 10, 10' and then to a remote reference database 20. At the remote reference database the information

included in the data signal is compared to stored information in the reference database according to the present invention.

First Preferred Embodiment

The first preferred embodiment of the present invention includes in the sensor unit 1, 1', containing or associated with a sensor means an activation means to activate a sensor unit to make a measurement of a parameter in an environment. The activation means is optionally based on a predetermined time or time interval. The activation means is optionally further combined with a comparison between a presently, measured value upon activation and a predetermined, stored, measurement value. This value may be, for example, a stored threshold concentration for a given gas, or a pH value. A decision to activate the sensor means and sensor unit and make a measurement is thus optionally based on a combination of either time alone or a predetermined measurement value and a time-based factor. A decision to activate based on a time or time interval is equivalent to detection step 400 of Figure 5. A decision to activate based on both a time factor and a measurement value is equivalent to step 401 of Figure 5, the decision to send step.

In the embodiment shown in Figure 3 the comparison for activation is carried out in the processor 5 and predetermined value/s for a measurement or of a time interval etc. are stored in the ROM memory means 4. In the embodiment shown in Figure 9 the comparison for activation is also carried out in processor 5, but stored predetermined values for the activation decision may be stored in part in additional and re-programmable memory means 7 as well as memory means 4. Such pre-determined values for activation stored in a re-programmable memory means such as means 7 may optionally be changed subsequently or optimised by downloading new or refined values from the reference database 20.

In another embodiment of the invention, a number of measurements are made by a sensor means and stored locally before transmitting them in one single transmission to the remote data reference for comparison.

In another embodiment of the invention the communication device may be a telephone that is substantially permanently connected to a fixed network, such as a PSTN. This is of particular advantage where a mobile service such as a cellular network service is not available or where a permanent requirement for monitoring and taking measurements of a parameter in an environment has been determined.

Second Preferred Embodiment

Figure 9 shows a sensor unit 1' according to a preferred embodiment of the invention. The sensor unit 1' comprises a sensor means 2, an amplifier and signal processor 3, and an identity of the sensor type of the sensor means stored in a memory means 4. An additional memory means 7, preferably re-writable is included. In one aspect of this embodiment a pre-determined number of measurements are made of an environmental parameter which are then and stored in the additional memory means 7. The stored results are then sent to the remote database in one single communication at another time.

In another aspect of this embodiment an additional memory storage program or software function is included to store a local copy 9 of selected pattern data downloaded or copied from the reference database 20 already described in previous embodiments. A local and modified version of the evaluation means, a software or a computer program product for carrying out a local equivalent of matching process 19, is also stored in the sensor unit or otherwise arranged capable of executing locally. The local data copy 9 is updated on a predetermined basis based on any of

-number of new measurements for a given parameter received at the remote reference,
-number of new measurements sent by the sensor means in question to the remote reference,
-a calculated change in a statistical measure of the type of results generated for the sensor in question and a given parameter,
-an interval of time,
-any combination of the above.

In a further other aspect of the embodiment a memory means, including a add on memory, plug in memory device or the like is arranged with the communication device and used to store the local copy (9) downloaded from the reference database. The communication device may optionally comprise processor means such that part or all of an evaluation process is carried out within the communication device circuits instead of by processor 5 of the sensor means.

Processor 5 has computer program means to carry out local signal matching between a signal and pattern from the sensor means 2 and patterns stored in the local copy 9 of reference data. The local copy 9 of reference data is optionally a set of patterns for the chemical substance(s) or parameter(s) monitored which have been identified by statistical means from analysis of successful comparison results for those parameters and downloaded to the sensor unit. The local copy 9 is optionally stored in the communication device, as described previously.

Re-programmable memory means 7, an EPROM, flash memory or the like, advantageously already contains on delivery of the parameter measurement system an address that the parameter measurement system should call to and send signals and or set up a matching service. Such an address may comprise any of:
a telephone number, a network address, an e-mail address, an Internet Protocol (IP) address, a web site address, a Universal

Resource Locator (URL), a Session Initiation Protocol (SIP) address.

The address information may later be up-dated or reprogrammed according to instructions delivered or downloaded from the reference database or other sources. This may be carried out by the owner or operator of the parameter measurement system by means of a log-in to a web site for instance, when reporting requirements stored in memory means 7 may be updated by downloading suitable code means or instructions to it.

In addition to address, reprogrammable memory means 7 may also include:

-sensor means type,
-sensor model and serial number
-identity or type of database to be accessed,
-signal processing if necessary to obtain patterns from the signal for matching,
-type of search or matching process to be used first,
-instructions for reporting result

Such details are also optionally updated subsequently by the owner or operator independently or in relation to communicating sensor signals to remote reference databases operated by different owners or operators.

In yet another aspect of the second preferred embodiment a local copy of reference data one or more patterns containing information derived from monitoring a parameter in an environment for comparison purposes, such as that data compared in a local database 9, is communicated to another system for monitoring an environment in order to carry out a local comparison with a measured parameter. In this case it may be that no cost has been incurred for a comparison in the remote reference database; however a billing transaction is instead registered for the other environment monitoring system for receiving the local copy of

patterns containing information derived from an environmental parameter stored in the remote reference.

A further added-value service is included in the preferred embodiment of the invention. When the detection of certain specified chemical substances is confirmed then after the result report is sent, or with the result report, a link is offered to the owner or operator of the sensor unit to a person or company providing a relevant service.

For example, when presence of Radon gas is confirmed for a sensor unit operated by a building contractor in a certain region. In this case the sensor owner or operator, the builder, may have agreed in advance in his/her contract that on report of a positive identfication of Radon over a predetermined threshold, that he/she wishes:

-to receive a list of Radon specialists in that region
-to get a contact number or active URL or hyperlink to a specialist
-that a specialist shall receive notification of the result and make contact with him/her.

It is also noted that while the above describes exemplifying embodiments of the invention, there are several variations and modifications which may be made to the disclosed solution without departing from the scope of the present invention as defined in the appended claims.

CLAIMS

1. A sensor means for monitoring an environment by means of sensed signals generated by at least one sensor unit for sensing a said environment and communicated over a communication network to an evaluation means (19) including information in a reference database (20), which said evaluation means may be located remote from a said environment to be sensed, for evaluation of one or more said sensed signals, said sensor means comprising a sensor unit (1) including a type of sensor for sensing the environment being monitored and for generating a sensed signal, the sensor unit also comprising input/output (I/O) means (6), **characterised** in that said sensor unit comprises I/O means arranged for transferring said sensed signal, or a signal representative of the sensed signal, to an input means of a telephone, the signal information received at said input means enabling the transfer of said sensed signal information to said evaluating means (19) by means in part of said telephone.

2. A sensor means according to claim 1, **characterised** in that said sensed signal information is further transferred to said evaluating means (19) via said communication network by means of said telephone.

3. A sensor means according to claim 1, **characterised** in that said sensor unit is incorporated in a telephone.

4. A sensor means according to claim 2, **characterised** in that the said sensor unit is incorporated in a cordless telephone.

5. A sensor means according to claim 2, **characterised** in that the said sensor unit is incorporated in a mobile telephone.

6. A sensor means according to claim 2, **characterised** in that the said sensor unit is incorporated in any of a mobile cellular

telephone, a GSM telephone, a GPRS telephone, a UMTS telephone, a WAP telephone, an I-mode telephone.

7. A sensor means according to claim 1, **characterised** in that said sensor unit (1, 1'') comprises a plug (112) for connection to a socket (113) means for an interface of a mobile telephone.

8. A sensor means according to claim 1, **characterised** in that said sensor unit (1, 1'') comprises a plug (112) for connection to a socket (113) means for a serial interface of a mobile telephone including any of RS232, USB.

9. A sensor means according to claim 7, **characterised** in that said sensor unit (1, 1'') is arranged comprising a plug (112) for connection to a socket (113) means of a telephone (10).

10. A sensor means according to claim 1, **characterised** in that said sensor unit (1, 1'') is connected to the telephone by a connector means including a wire (123).

11. A sensor means according to claim 1, **characterised** in that said sensor unit (1, 1'') is connected to the telephone by a wireless means (132, 133).

12. A sensor means according to claim 1, **characterised** in that said sensor unit (1, 1'') is connected to the telephone by a radio transmitter/receiver means (132, 133, 5) compatible with according to a standard of the Bluetooth SIG.

13. A sensor means according to claim 1, **characterised** in that said sensor unit (1, 1'') is connected to the telephone by a radio transmitter/receiver means (132, 133, 35) compatible with to a standard of IEEE-802.11, IEEE-802.13 or equivalent.

14. A sensor means according to claim 1, **characterised** in that said type of sensor comprises a gas sensor array (2).

15. A sensor means according to claim 1, **characterised** in that said type of sensor comprises means for detecting and measuring electromagnetic radiation, e.g. visible, UV or IR radiation.

16. A sensor means according to claim 15, **characterised** in that said type of sensor comprises an optical waveguide arranged for capture and subsequent measurement of fluorescent light.

17. A sensor means according to claim 15, **characterised** in that said type of sensor comprises a photo-optic receptor.

18. A sensor means according to claim 15, **characterised** in that said type of sensor comprises a plurality of optical fibres arranged to receive light transmitted through a sample of biological origin located at said environment and to provide a measurement signal representative of the different wavelengths of light.

19. A sensor means according to claim 1, **characterised** in that said type of sensor comprises a probe for pH measurement.

20. A sensor means according to claim 1, **characterised** in that said type of sensor comprises means for measuring ionizing radiation, such as a geiger counter.

21. A sensor means according to claim 1, **characterised** in that the sensor unit comprises a sensor arranged to respond to a graphic pattern.

22. A sensor means according to claim 21, **characterised** in that the sensor unit comprises a sensor arranged to respond to a

graphic pattern such as a number, character string or combination thereof.

23. A sensor means according to claim 1, **characterised** in that said type of sensor includes means for generating a graphic pattern.

24. A sensor means according to claim 23, **characterised** in that said type of sensor includes means for generating a graphic pattern, such as a scan dependent on a finger print, a hand print, a skin pattern, a retina scan, or other biometric sensor application.

25. A sensor means according to claim 1, **characterised** in that said type of sensor comprises transducer means for detecting and measuring a sound, such as breaking glass, a gunshot, a ringing telephone, a voice, an alarm bell, buzzer or siren, for example a microphone.

26. A sensor means according to claim 25, **characterised** in that transducer means is arranged for detecting and measuring an ultrasound transmission.

27. A sensor means according to claim 25, **characterised** in that the sensor unit comprises transducer means for detecting and measuring a pressure pulse in a solid, including an event of seismic origin, or in a fluid, for example a microphone.

28. A sensor means according to claim 1, **characterised** in that the sensor unit comprises means to detect smoke and/or soot or other particles from a heating, pyrolysis or combustion process.

29. A sensor means according to claim 1, **characterised** in that said sensor means includes identifying data identifying the said sensor means.

30. A sensor means according to claim 29, **characterised** in that the identifying data identifying the said sensor means may comprise any of a said sensor type, sensor type supplier.

31. A sensor means according to claim 1, **characterised** in that the sensor means comprises signal processing means (3), memory means (4), computing or processing means (5) and input/output (I/O) means (6).

32. A sensor means according to claim 28, **characterised** in that an identifying data identifying the said sensor means may be held in memory means (4) of the sensor means.

33. A sensor means according to claim 28, **characterised** in that an identifying data identifying the said sensor means may be held in a circuit of the telephone (10) means.

34. A sensor means according to claim 28, **characterised** in that an identifying data identifying the said sensor means may be held in a memory means of a mobile telephone.

35. A sensor means according to claim 2, **characterised** in that said sensed signal information is further transferred to said evaluating means by means of a communication network including any of a LAN, WAN, an intranet, the Internet.

36. A sensor means according to claim 1, **characterised** in that the telephone means comprises a memory means suitable to store a local copy (9) of reference data downloaded from a reference database (20).

37. A sensor means according to claim 28, **characterised** in that the sensor means comprises a processor (5) and computer program means to compare said sensed signal with the local copy (9) of

said downloaded reference data stored in a memory means comprised in the telephone means.

38. A sensor means according to claim 37, **characterised** in that the sensor means comprises a processor (5) and memory means (4, 7) and computer program product means to compare a sensed signal with a local copy (9) of a downloaded reference data.

39. A sensor means according to any of claims 1-38 **characterised** in that the telephone means is comprises a hand-held computing device.

40. A sensor means according to claim 39, **characterised** in that the hand-held computing device comprises communication means, such as a modem or wireless modem.

41. A sensor means according to claim 1, **characterised** in that said sensor means contains on delivery of said sensor means an address that the sensor means system should call to and send signals and/or set up a matching service.

42. A sensor means according to claim 41, **characterised** in that the address said sensor means contains on delivery may comprise any of: a telephone number, a network address, an e-mail address, an Internet Protocol (IP) address, a web site address, a Universal Resource Locator (URL), a Session Initiation Protocol (SIP) address.

43. A sensor means according to claim 41, **characterised** in that said sensor means may receive into memory means (4, 7) a suitable code means and/or update and/or instructions downloaded from the reference database (20) comprising any of: identity or type of database to be accessed; signal processing if necessary to obtain patterns from the signal for matching; type of search or matching process to be used first; instructions for reporting result.

44. A system for monitoring one or more environments by means of evaluation of sensed signals generated by at least one sensor unit (1) for sensing a said environment, said system including means (19) for evaluation of one or more said sensed signals, and evaluating means (19) including information in a reference database (20) for assisting evaluation of the sensed information situated at a location remote from the or each environment being monitored, **characterised** in that said sensor unit comprises means for transfer of a said sensed signal by means of a telephone for to said evaluating means (19).

45. A system according to claim 44, **characterised** in that said evaluating means (19) of said system is arranged accessible over a communication network.

46. A system according to claim 45, **characterised** in that said evaluating means (19) of said system is arranged accessible over a communication network comprising a telecommunication network for which the telephone means is configured.

47. A system according to claim 44, **characterised** in that said evaluating means (19) includes information in a reference database (20) for assisting evaluation of the sensed information.

48. A system according to claim 44, **characterised** in that said evaluating means (19) includes a second reference database (26) containing information about registered users of the monitoring system.

49. A system according to claim 44, **characterised** in that said evaluating means includes information in second reference database (26) for matching with an identifying data received from said sensor unit to enable the evaluating means (19) to identify from which said sensor means (1) associated said sensed signal has been received from.

50. A system according to claim 44, **characterised** in that said evaluating means (19) includes an interface (18) for identifying a registered user of a sensor means by matching data received including said sensed signal together with data stored in the second reference database (26) which may include any of: sensor unit identifier, telephone identity, ESN number, MIN number, incoming phone number, incoming address, incoming Internet Protocol (IP) address.

51. A system according to claim 45, **characterised** in that the communication network comprises a telecommunication network such as a mobile cellular network.

52. A system according claim 45, **characterised** in that the communication network comprises a Public Switched Telephone Network (PSTN) to which the telephone is connected.

53. A system according to claim 45, **characterised** in that the communication network comprises a radio or satellite based network.

54. A system according to claim 45, **characterised** in that the communication network comprises a Private Telephone Exchange (PABX) system to which the telephone is connected.

55. A system according to claim 44, **characterised** in that an interface (18) of said reference data arranged in the remote database (20) is arranged configurable to download a copy (9) of a part of the reference data for storage in a memory means (4, 7) of the sensor unit for comparison locally in the sensor unit.

56. A system according to any of the preceding claims 44-55, **characterised** in that the evaluating means forms part of a web site located in a network node or on the Internet.

57. A system according to any of the preceding claims, **characterised** in that the monitoring system includes a plurality of sensor units (1) including sensor units for different gases.

58. A system according to any of the preceding claims, **characterised** in that the monitoring system includes a plurality of sensor units (1) including any of: sensors for gases, optical sensors for fluorescent light, visible, UV or IR light, sensors with transducer means for sound and/or ultrasound, sensors for soot and or smoke particles.

59. A method of monitoring an environment comprising generating a sensed signal representative of the environment being monitored, and evaluating said sensed information at an evaluating means (19), which said evaluating means may be situated at a location remote from the environment being monitored, **characterised** by
-transferring a sensed signal by means of a sensor unit (1) to a telephone,
-transmitting said sensed signal to said evaluating means (19) at least in part by means of the telephone,
-evaluating said sensed signal at the evaluating means (19).

60. A method according to claim 59, **characterised** by transmitting said sensed signal directly to said evaluating means (19).

61. A method according to claim 59, **characterised** by transmitting said sensed signal via a communications network to said evaluating means (19).

62. A method according to claim 59, **characterised** by including an identifying data with said sensed signal which identifying data identifies the said sensor means.

63. A method according to claim 59, **characterised** in that said sensed signal received at said evaluating means is compared with reference data stored at the evaluating means.

64. A method according to claim 63, **characterised** in that a report is sent to at least one predetermined destination as a result of the evaluation of the sensed signal at said evaluating means.

65. A method according to claim 64, **characterised** in that a at least one predetermined destination for the report may be a telephone.

66. A method according to claim 64, **characterised** in that a at least one predetermined destination for the report may be a telephone that originated communicated a said sensed signal.

67. A method according to any of claims 59-66, **characterised** by the further step of matching at said evaluating means the sensor identifying data of sensed signal with stored user information.

68. A method according to any of claims 61-66, **characterised** in that said communication network includes the Internet.

69. A method according to any of claims 61-66, **characterised** in that said communication network 10 includes a LAN, WAN or intranet.

70. A method according to any of claims 61-66, **characterised** in that by processing said sensed signal at said evaluating means by means of a statistical process, such as PCA, PLS, or MRL.

71. A method according to any of claims 59-67, **characterised** by processing said sensed signal at said evaluating means (19) by means of a neural network.

72. A method according to claim 59, **characterised** in that said evaluating means is trained by means of a neural network.

73. A method according to any of claims 59-72, **characterised** in that the copy of the result report stored in the user history database is associated with the environment being monitored by any of: incoming phone number, phone number accessed at the evaluating means, transmitting phone ESN number, transmitting phone MIN number, incoming IP address, IP address accessed at the evaluating means, an incoming e-mail address, an e-mail address at evaluating means, a SIP address or a URL address.

74. A method according to claim 59, **characterised** by sending information dependent on said sensor signal to a centre for reporting emergency situations by use of configurable software means of the interface (18).

75. A method according to claim 74, **characterised** by sending information dependent on said sensor signal from a centre for reporting emergency situations to a predetermined report destination by use of configurable software means of the interface (18).

76. A method according to claim 73, **characterised** in that the copy of the result report stored in the user history database is associated with data from the telephone network identifying the location of the originating mobile phone 10.

77. A method according to any of claims 59-66, **characterised** in that the environment being monitored is sensed to provide a measured value following an activation process in which any of a time, a time interval or a predetermined measurement value are evaluated.

78. A method according to any of claims 59-66, **characterised** in that a copy (9) of part of said reference database is downloaded to the sensor unit (1) for local comparison.

79. Use of a sensor unit (1) according to any of claims 1 to 43 to provide an alarm system for the detection and report of chemical substances in the environment being monitored, such as an industrial plant, an airport, a paper mill, petroleum refinery or vehicle assembly plant.

80. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a security system for the detection of explosive and/or flammable materials in the environment being monitored.

81. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a condition monitoring system to monitor the condition of a person.

82. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a condition monitoring system to monitor the condition of a person based on detectable substances related to a sickness, an injury or other indicators of a physiological state of the person.

83. Use of a sensor unit (1) according to any one of claims 1 to 43 in a hospital to provide a condition monitoring system for a chemical substance, including a substance related to the health of a staff member, visitor or a patient.

84. Use of a sensor unit (1) according to any one of claims 1 to 43 in a home, residence and surrounding environment to provide a monitoring system for an environmental parameter related to the physiological state of a person.

85. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a condition monitoring system to monitor the condition of an animal.

86. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a condition monitoring system to monitor the condition of a plant or organism of botanic origin.

87. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a condition monitoring system to monitor the condition of micro-organisms.

88. Use of a system according to any one of claims 1 to 43 to provide a condition monitoring system for monitoring a sample of biological origin for parameters indicating a presence of any one of a bacteria, a virus, a micro-organism.

89. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a monitoring system to monitor an environmental parameter contained in or dependent on a food or a food product.

90. Use of a sensor unit (1) according to any one of claims 1 to 43 to provide a condition monitoring system for a chemical substance including information about the location of the sensed chemical substance.

91. Use of a sensor unit (1) according to any one of claims 1 to 43 for the detection and report of chemical substances in an air handling system of an environment being monitored, such as a building, a hospital, an industrial plant, an airport, a paper mill, petroleum refinery or vehicle assembly plant.

92. A computer data signal embodied in a data communication for evaluation of sensed signals generated by at least one sensor unit (1) for monitoring one or more environments, said data signal comprising measured information dependent on a measurement made by a sensor means (1) of a monitored environment, said sensor unit comprising means for transfer of a said sensed signal to a telephone means, **characterised** in that said signal is sent over a communications network and comprises said measured information

(505) and an identifying means (503), such as a number, character string or combination thereof, so that the said sensor means (1) may be identified.

93. A computer data signal according to claim 92, characterised in that it is embodied in a format derived from SGML such as any one of XML, XHTML, HTML, WML, or equivalent.

94. A computer program product for evaluation of sensed signals generated by at least one sensor unit (1) for monitoring one or more environments, comprising computer code means or software code portions for enabling a computer or a processor to carry out one or more of a series of instructions embodied in a memory means of a sensor unit (1), said sensor unit comprising means for transfer of a said sensed signal to a telephone means, **characterised** in that said computer or processor (5) is made to carry out actions to combine an identifying data stored in a memory means (4, 7) of said sensor unit with the said sensed signal for identification of said sensor unit generating said signal.

95. A sensor means for monitoring an environment by means of evaluation of sensed signals generated by at least one sensor unit for sensing a said environment and evaluation means (19) for evaluation of one or more said sensed signals, said evaluating means (19) including information in a reference database (20) which may be located remote from an environment to be sensed comprising a sensor unit (1) including a type of sensor for sensing the environment being monitored and for generating a sensed signal, the sensor unit also comprising input/output (I/O) means, **characterised** in that the sensor unit comprises I/O input/output means for transferring said sensed signal, or a signal representative of the sensed signal, to an input means of a telephone, enabling the transfer of said sensed signal and/or information representative of the sensed signal to said evaluating means (19).

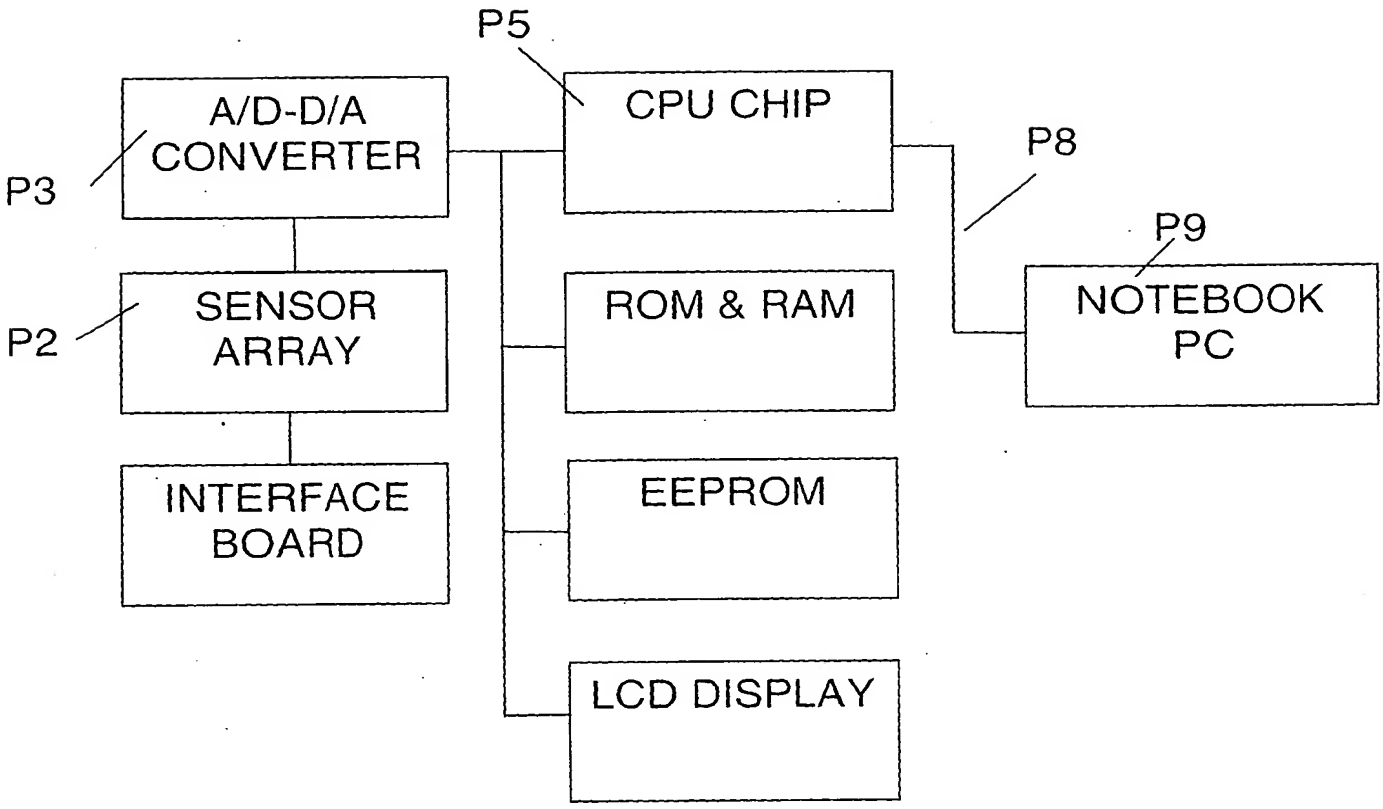


Figure 1 (Prior Art)

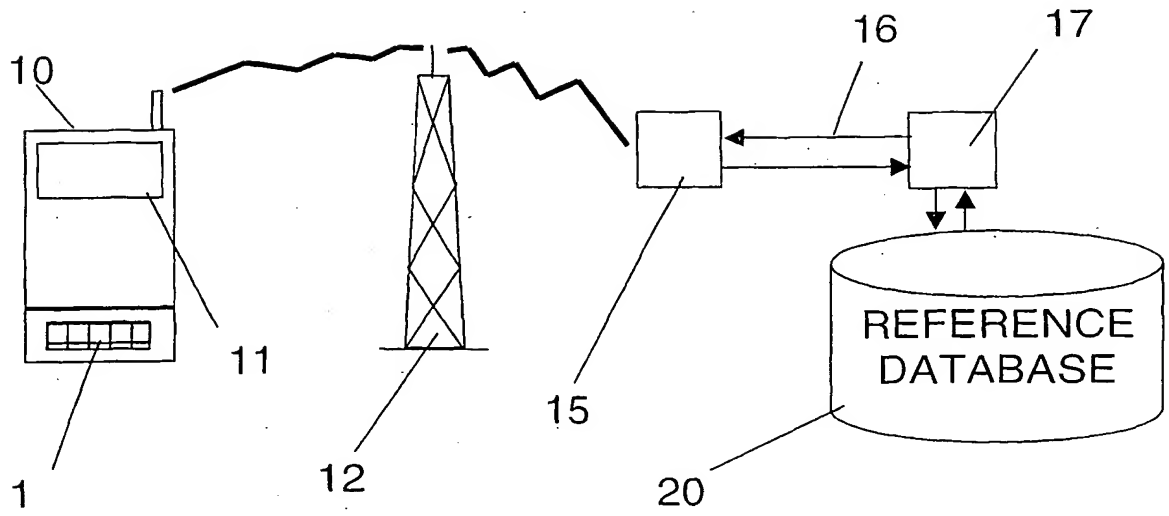


Figure 2

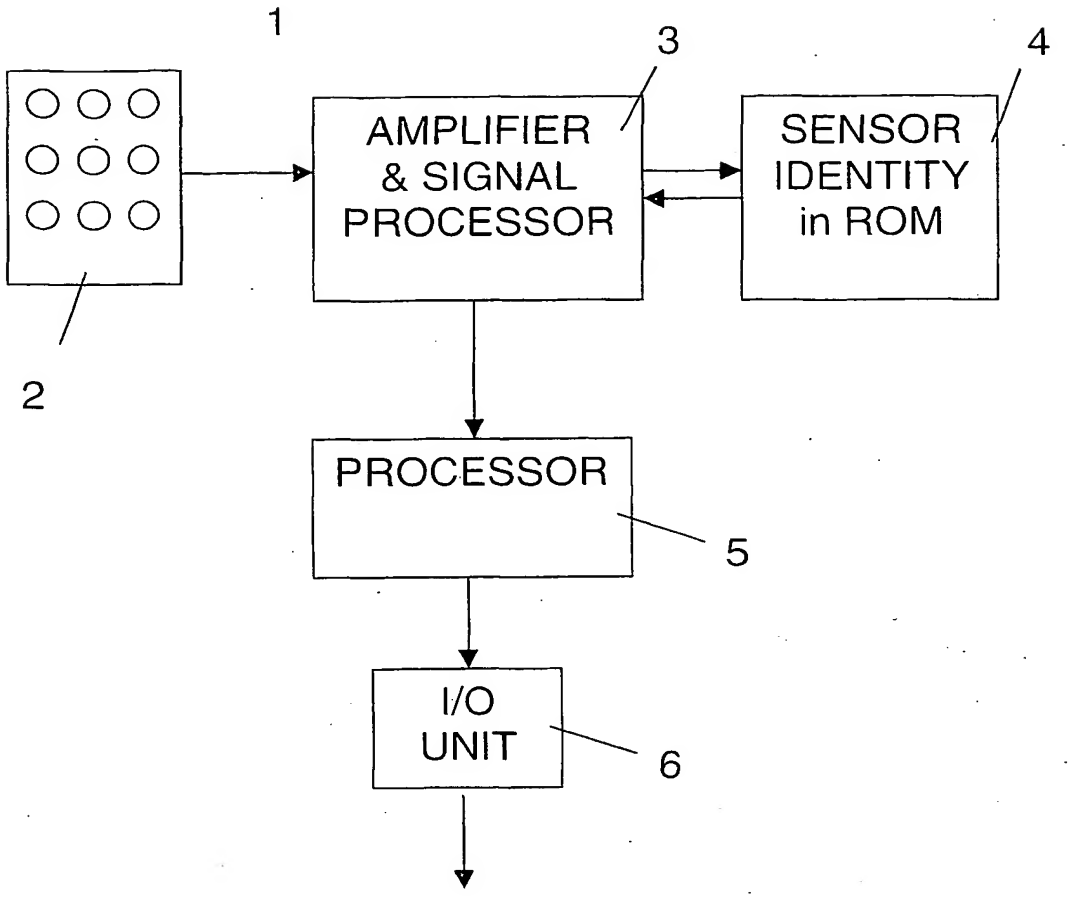

1
3
4
AMPLIFIER
& SIGNAL
PROCESSOR
SENSOR
IDENTITY
in ROM
2
PROCESSOR
5
I/O
UNIT
6

Figure 3

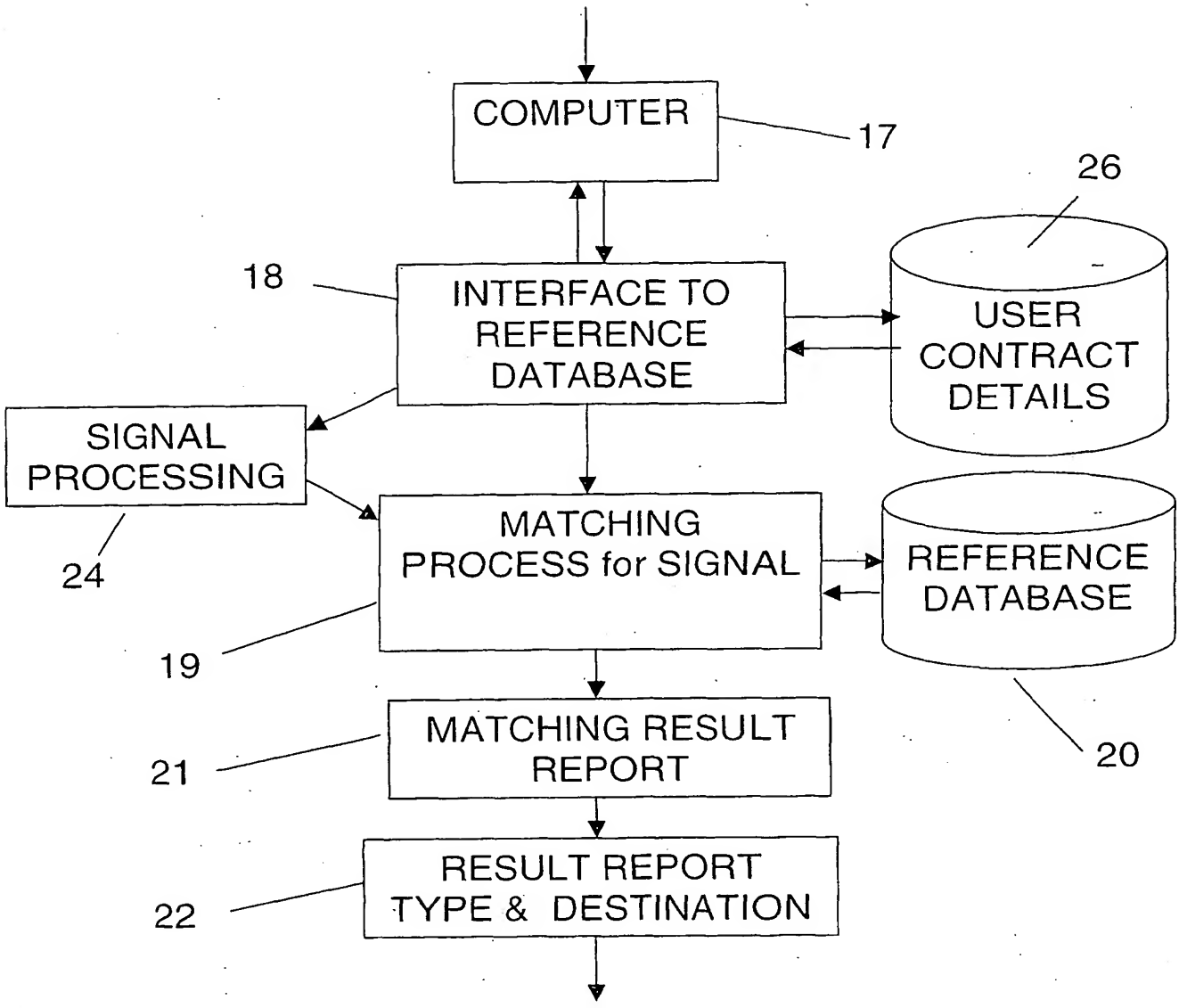

COMPUTER
17
26
18
INTERFACE TO REFERENCE DATABASE
USER CONTRACT DETAILS
SIGNAL PROCESSING
24
MATCHING PROCESS for SIGNAL
REFERENCE DATABASE
19
20
MATCHING RESULT REPORT
21
RESULT REPORT TYPE & DESTINATION
22

Figure 4

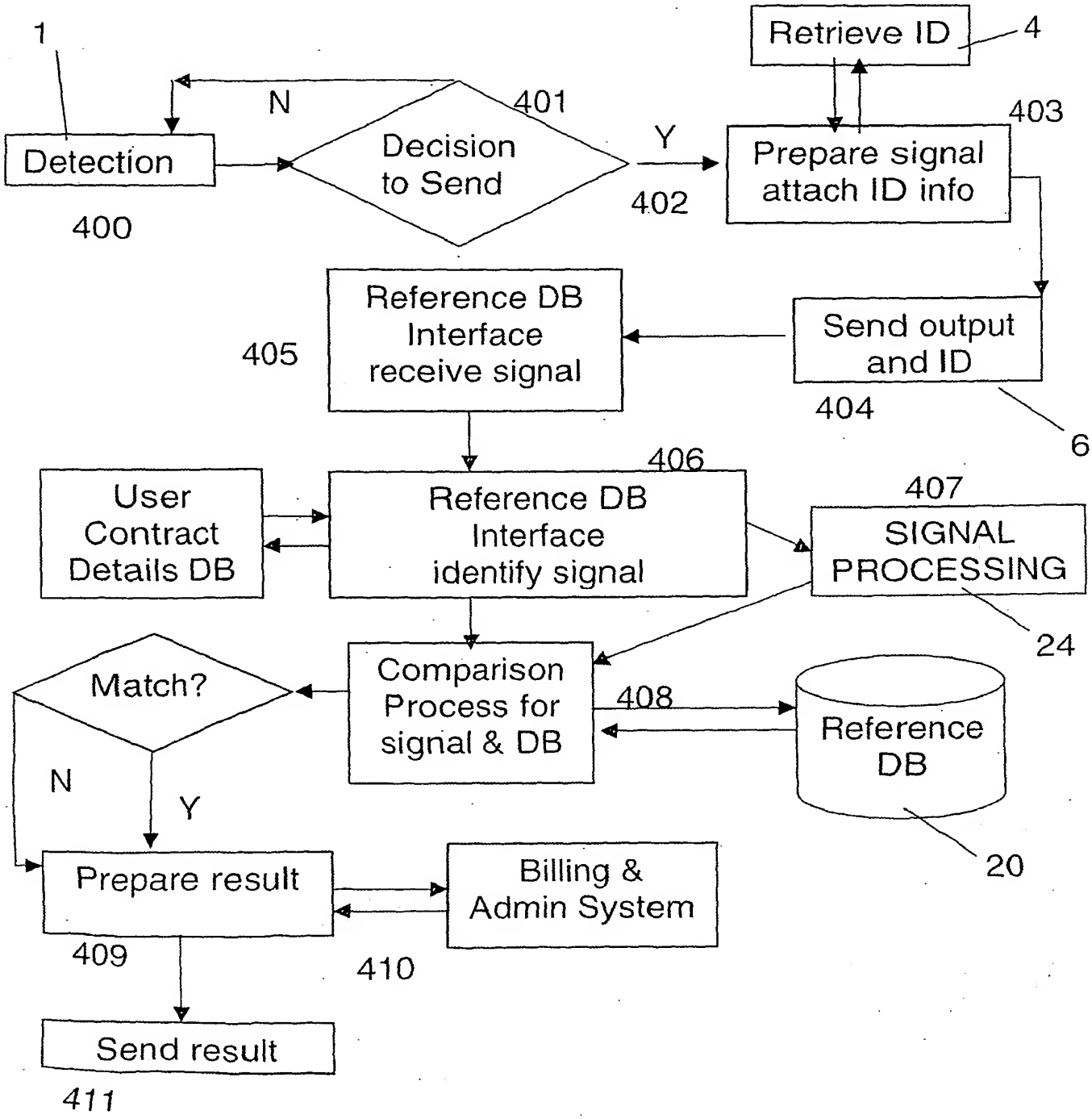

1
Retrieve ID
4
N
401
Detection
Decision to Send
Y
403
Prepare signal attach ID info
400
402
Reference DB Interface receive signal
405
Send output and ID
404
6
406
User Contract Details DB
Reference DB Interface identify signal
407
SIGNAL PROCESSING
24
Match?
Comparison Process for signal & DB
408
Reference DB
N
Y
20
Prepare result
Billing & Admin System
409
410
Send result
411

Figure 5

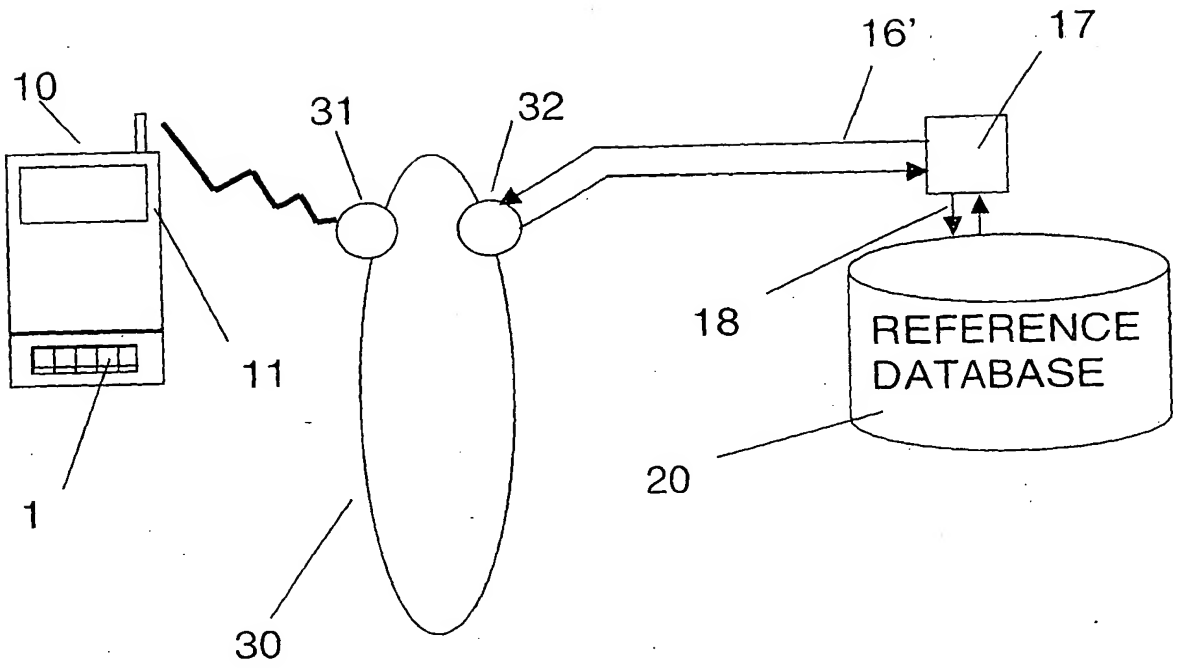


Figure 6

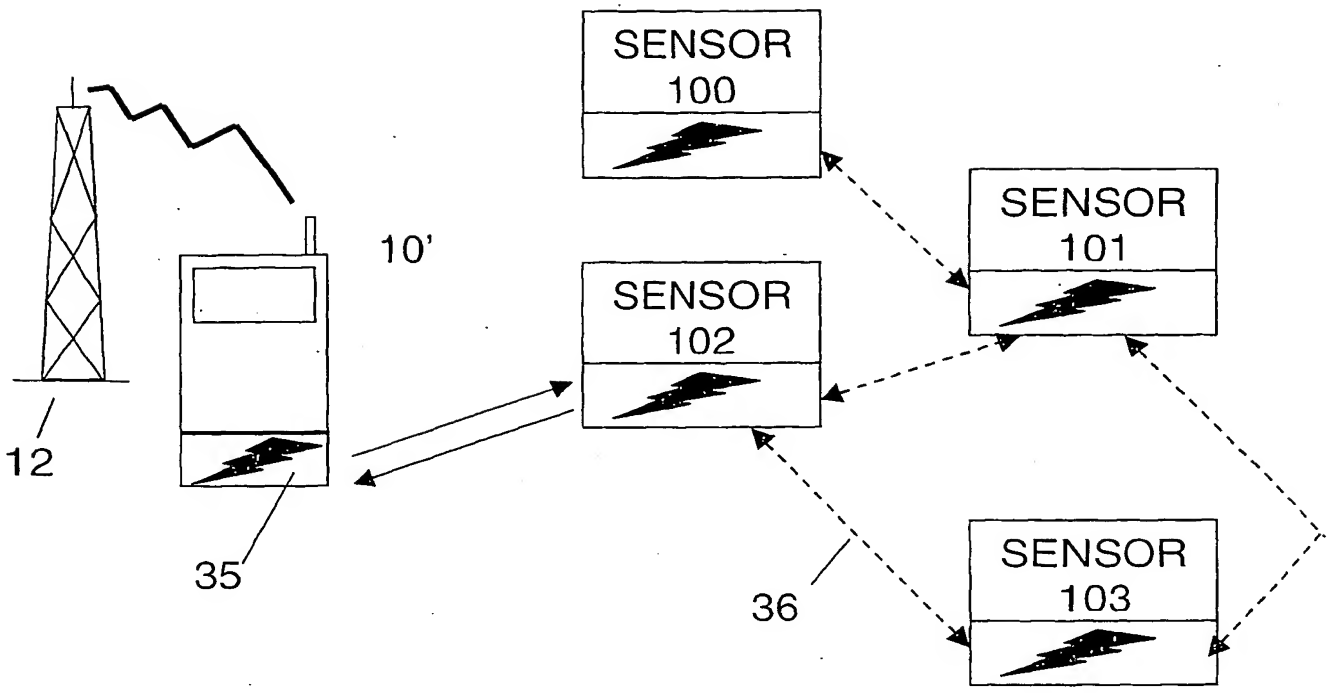


Figure 7

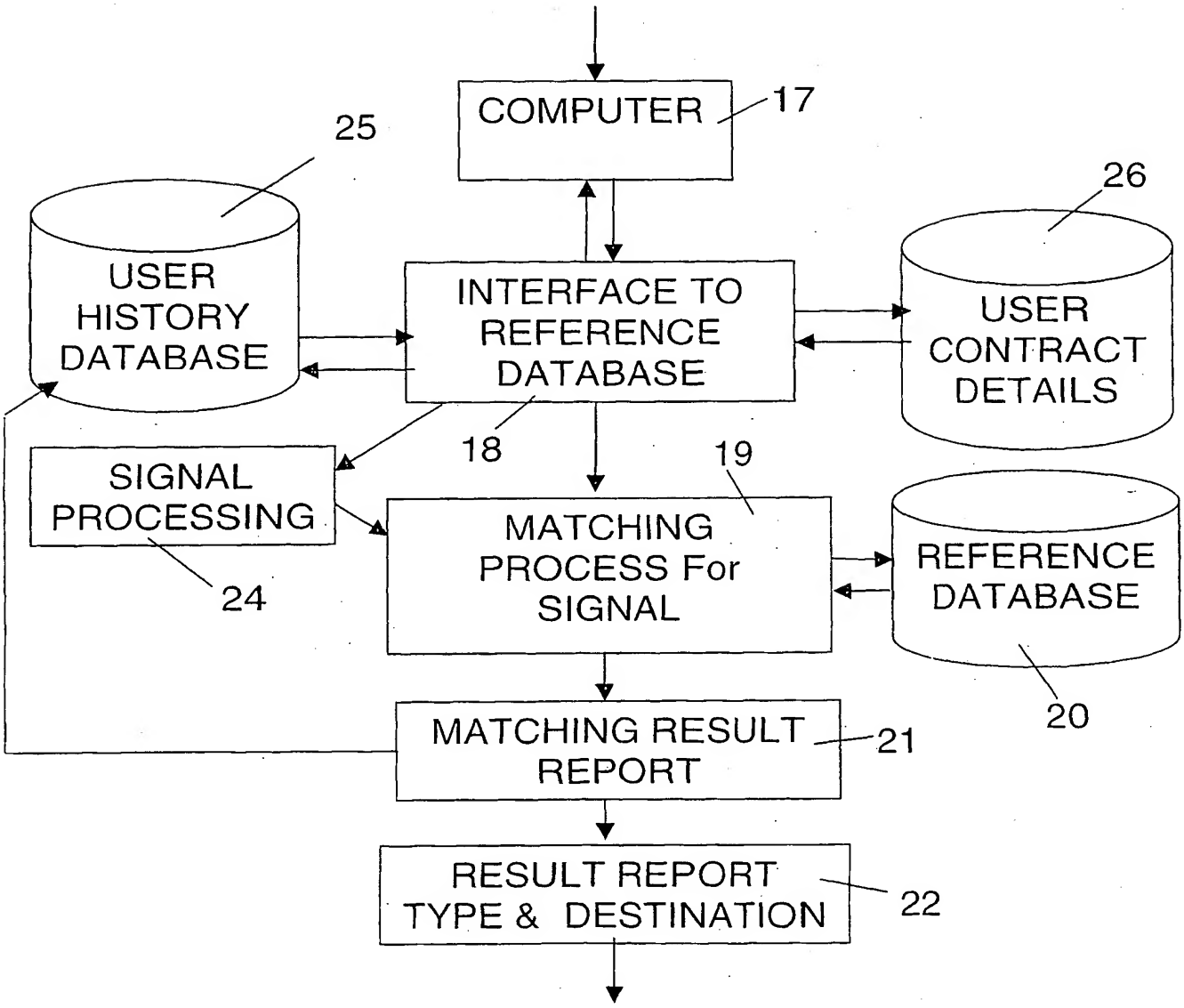
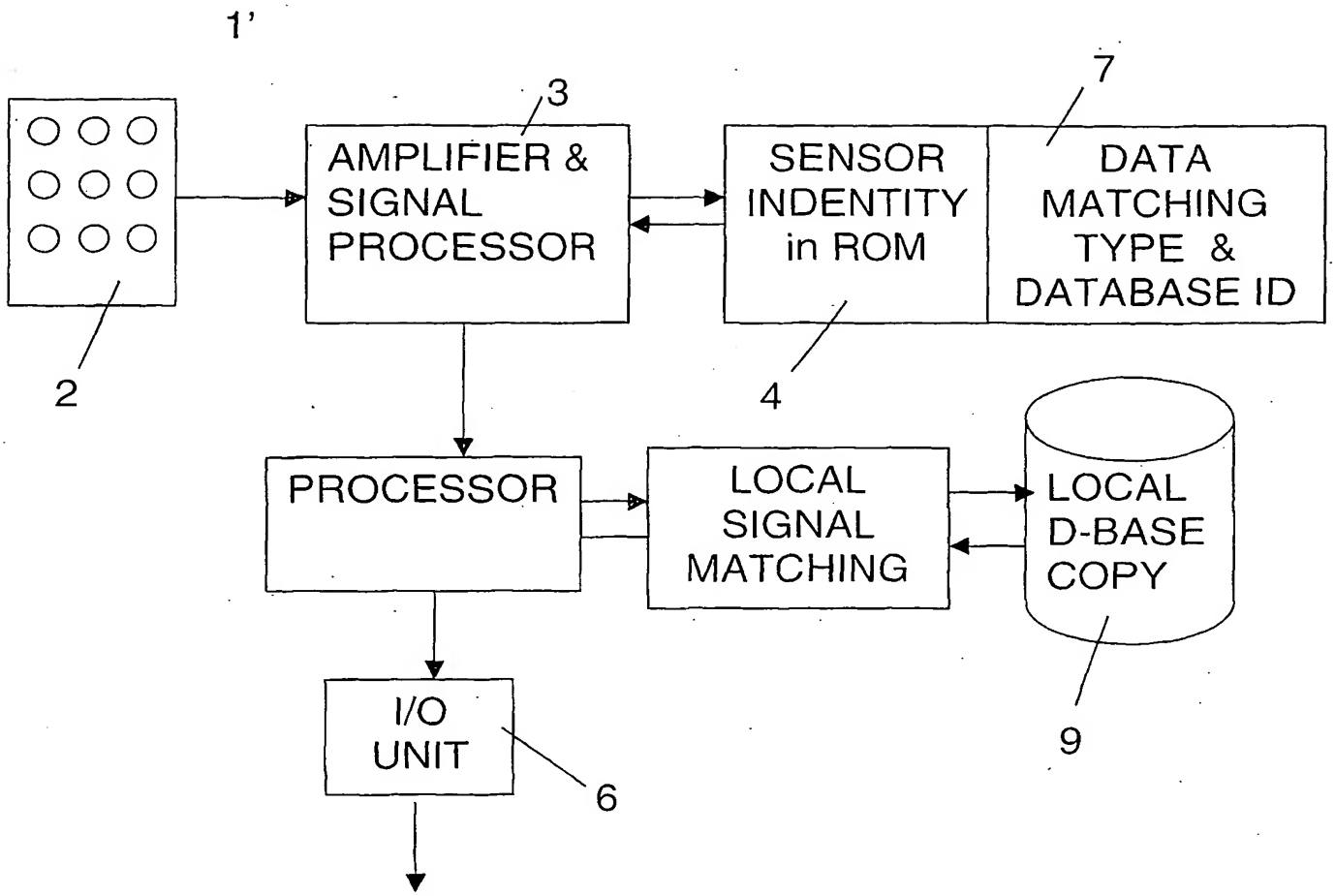

COMPUTER
17
25
26
USER HISTORY DATABASE
INTERFACE TO REFERENCE DATABASE
USER CONTRACT DETAILS
18
19
SIGNAL PROCESSING
24
MATCHING PROCESS For SIGNAL
REFERENCE DATABASE
20
MATCHING RESULT REPORT
21
RESULT REPORT TYPE & DESTINATION
22

Figure 8


1'
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7
AMPLIFIER & SIGNAL PROCESSOR
SENSOR INDENTITY in ROM
DATA MATCHING TYPE & DATABASE ID
2
4
PROCESSOR
LOCAL SIGNAL MATCHING
LOCAL D-BASE COPY
I/O UNIT
6
9

Figure 9

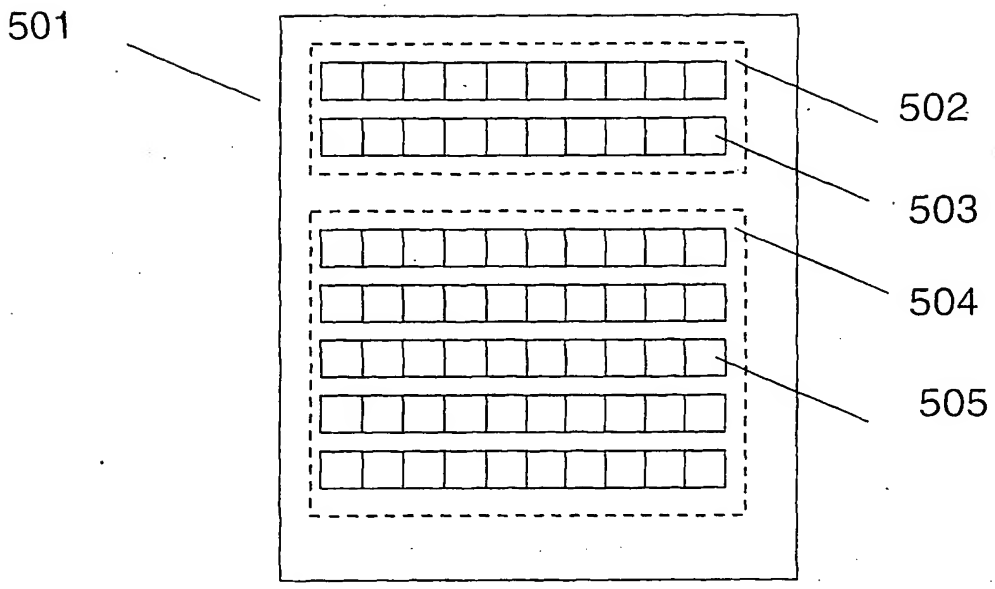

Figure 10

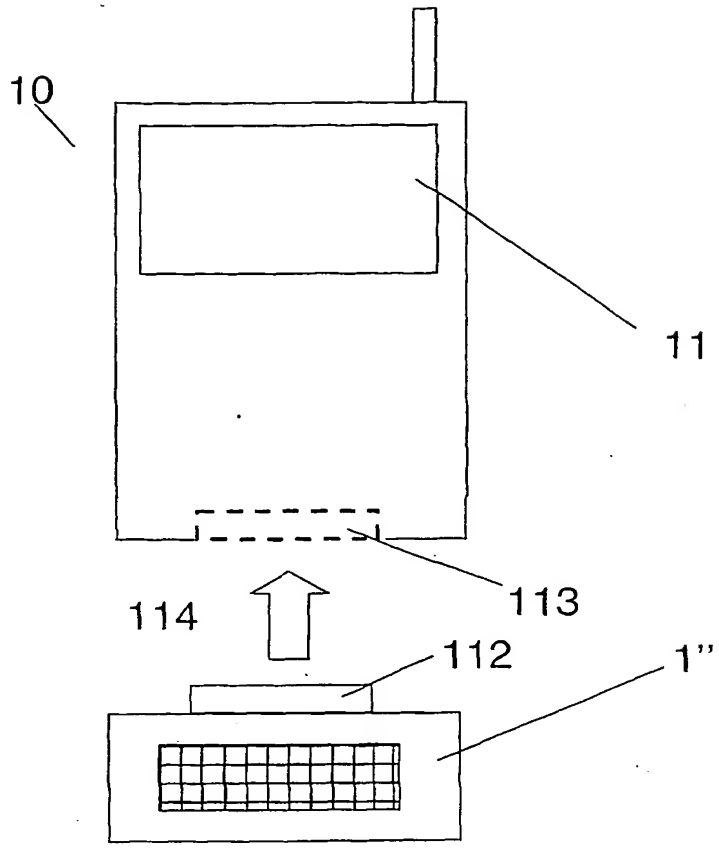

Figure 11

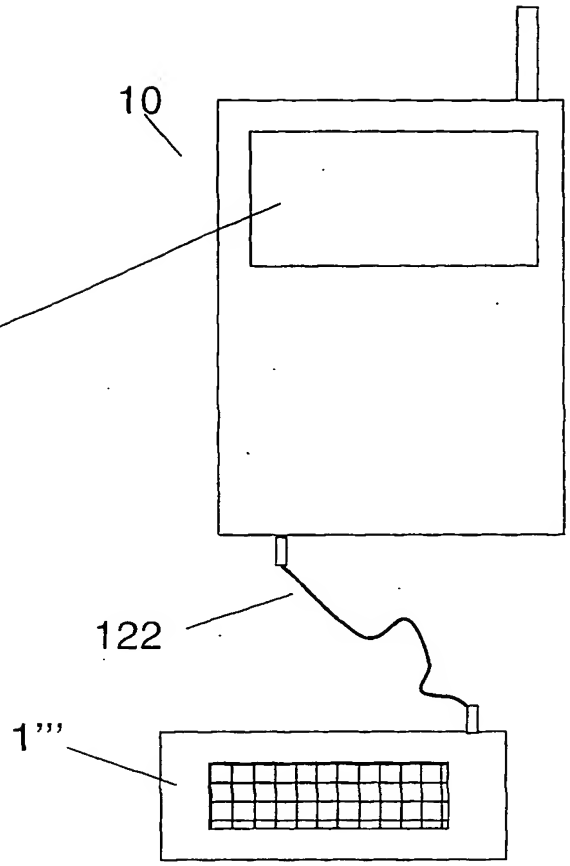

Figure 12

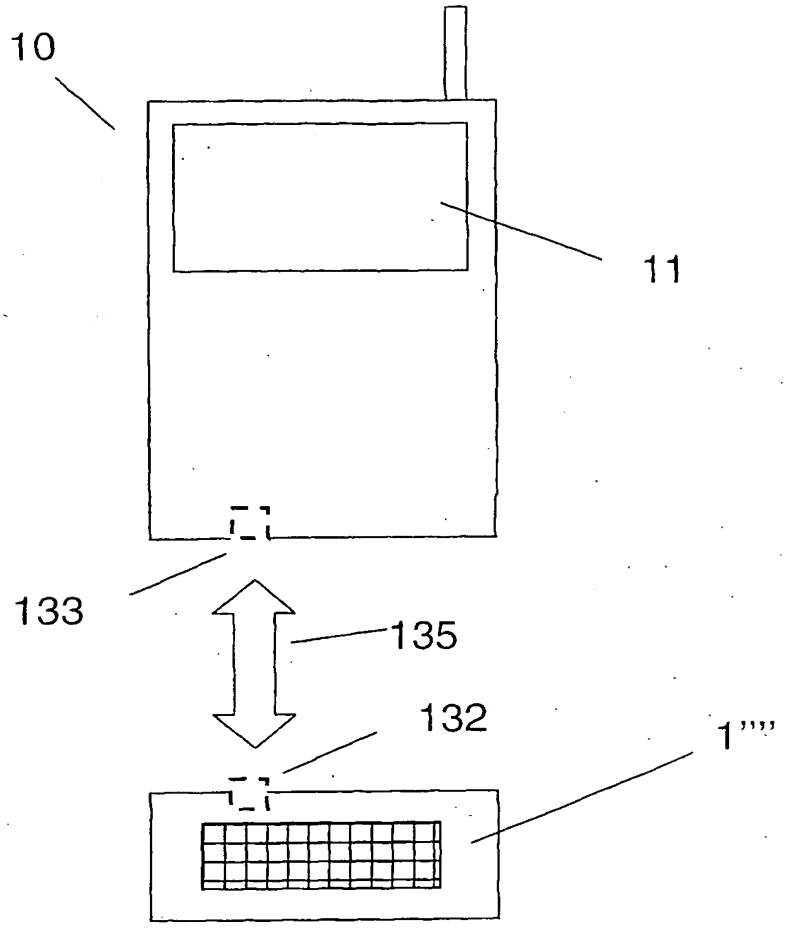

Figure 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02328

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G08C 17/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G08C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 0052444 A2 (CYRANO SCIENCES, INC.), 8 Sept 2000 (08.09.00), page 1, line 14 - page 8, line 5, figures 16,17	1-95
X	WO 9946921 A2 (NOKIA MOBIE PHONES LTD.), 16 Sept 1999 (16.09.99), page 2, line 20 - page 6, line 3, figures 1,4, Table 1	1-15,20, 28-80,83, 90-95
P,X	WO 0078204 A2 (CALIFORNIA INSTITUTE OF TECHNOLOGY), 28 December 2000 (28.12.00), page 3, line 22 - page 5, line 23, figure 1A	1-95

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 January 2002	08-02-2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Stefan Hansson/js Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02328

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 0113558 A1 (PHOENIX DATACOMM, INC.), 22 February 2001 (22.02.01), page 2, line 18 - page 3, line 18 -- --------	1-95

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 01/02328

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0052444 A2	08/09/00	AU 4970600 A	21/09/00
		US 6234006 B	22/05/01
		US 2001039824 A	15/11/01
		AU 3105099 A	11/10/99
		CN 1301342 T	27/06/01
		EP 1064530 A	03/01/01
		US 6085576 A	11/07/00
		US 6305980 B	23/10/01
		US 2001008816 A	19/07/01
		WO 9947905 A	23/09/99
		AU 1655101 A	14/05/01
		WO 0133212 A	10/05/01
WO 9946921 A2	16/09/99	AU 2426999 A	27/09/99
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		FI 980538 A,V	10/09/99
WO 0078204 A2	28/12/00	AU 6046700 A	21/11/00
		WO 0068675 A	16/11/00
WO 0113558 A1	22/02/01	AU 6919800 A	13/03/01